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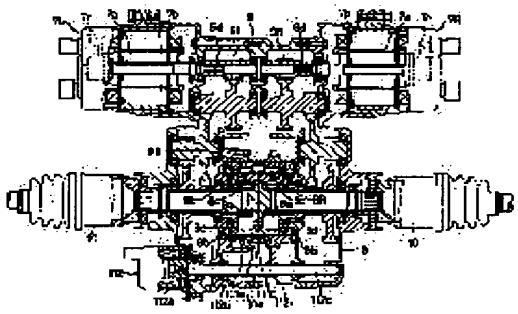
(54) ELECTRIC DRIVING SYSTEM FOR VEHICLE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the reliability of take-off assist by providing controlling means for controlling to increase/decrease input torque of an electric motor.
SOLUTION: For take-off assist, output torque of electric motors 7L, 7R are controlled in order to prevent a rear wheel from slipping. Acceleration of each left and right wheel is calculated based on the signal variation of a rear wheel speed sensor, then it is judged whether or not each acceleration is above the first set value, a criterion for slip. If the acceleration is above a first set value, it is judged whether or not the acceleration is below a second set value criterion for grip recovery. If the acceleration is below the second set value, a target value of output torque of the respective electric motors 7L, 7R is set higher. If the acceleration is above the first set value, a target value of output torque of the electric motors 7L, 7R is set lower. Each of the electric motors 7L, 7R is thereby driven controlled so that its output torque becomes the target value.



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*.NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The electromotive driving gear for cars characterized by what a coupled driving wheel is driven on the driving wheel which drives one side of a front wheel and a rear wheel with an engine, and the car which uses another side as a coupled driving wheel with an electric motor, and it is equipped with the control means which carries out increase and decrease of the output torque of an electric motor of control according to the angular acceleration of a coupled driving wheel at the time of the drive of the coupled driving wheel by the electric motor for in the electromotive driving gear for cars formed that start of a car should be assisted.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the electromotive driving gear for cars carried in the driving wheel which drives one side of a front wheel and a rear wheel with an engine, and the car which uses another side as a coupled driving wheel.
[0002]
[Description of the Prior Art] To mu of a road surface, although what drives a coupled driving wheel with an electric motor, and assisted start of a car as this kind of equipment at the time of start on low mu ways (mu is coefficient of friction), such as a snowy road, is known conventionally, if the driving force of a coupled driving wheel is excessive, a coupled driving wheel slips and the effectiveness of start assistance may not no longer be acquired.
[0003] Then, the slip ratio of a driving wheel is calculated from the rotational-speed difference of a driving wheel and a coupled driving wheel, it asks for mu of a road surface from the correlation of this slip ratio and the driving force of a driving wheel, and what prevented the slip of the coupled driving wheel at the time of start assistance is known by controlling the output torque of an electric motor to the value according to this mu (refer to JP,8-300965,A).
[0004]
[Problem(s) to be Solved by the Invention] It is the thing of the above-mentioned conventional example, and what it is asking for is the road surface mu of the touch-down part of a driving wheel, the road surface mu of the touch-down part of a coupled driving wheel becomes excessive [the output torque of an electric motor], when lower than the road surface mu of the touch-down part of a driving wheel, and produces a slip of a coupled driving wheel, the output torque of an electric motor is regulated superfluously and a part conversely higher than the road surface mu of the touch-down part of a driving wheel has the fault by which the certainty of start assistance is spoiled.
[0005] This invention makes it the technical problem to offer the electromotive driving gear for cars the certainty of start assistance was made to improve by controlling the output torque of an electric motor appropriately according to the road surface mu of the touch-down part of a coupled driving wheel in view of the above point.
[0006]
[Means for Solving the Problem] That the above-mentioned technical problem should be solved, this invention drove the coupled driving wheel on the driving wheel which drives one side of a front wheel and a rear wheel with an engine, and the car which uses another side as a coupled driving wheel with the electric motor, and equips it with the control means which carries out increase and decrease of the output torque of an electric motor of control according to the angular acceleration of a coupled driving wheel at the time of the drive of the coupled driving wheel by the electric motor in the electromotive driving gear for cars formed that start of a car should be assisted.
[0007] If the driving force of a coupled driving wheel becomes excessive to the road surface mu of the touch-down part of a coupled driving wheel and a coupled driving wheel slips, the angular acceleration of a coupled driving wheel will increase. Therefore, the angular acceleration of a coupled driving wheel serves as a parameter showing the road surface mu of the touch-down part of a coupled driving wheel, and the output torque of an electric motor will be appropriately controlled according to the road surface mu of the touch-down part of a coupled driving wheel by fluctuating the output torque of an electric motor according to this angular acceleration.
[0008] The road surface mu of the touch-down part of a coupled driving wheel is low, and when a coupled driving wheel becomes with some slip and angular acceleration increases, the output torque of an electric motor can be

decreased, a grip can be recovered at an early stage, and when angular acceleration does not increase highly, a road surface mu makes the output torque of an electric motor increase, and, specifically, can perform start assistance efficiently.

[0009] In addition, in the operation gestalt which carries out a postscript, processing from the step of S91 and S92 of drawing 4 to the step of S141 and S142 is equivalent to the above-mentioned control means.

[0010]

[Embodiment of the Invention] Drawing 1 shows the front-wheel drive car which drives the front wheels 3L and 3R on either side through a change gear 2 with an engine 1, and has formed the electromotive driving gear 5 between rear wheel 4L of coupled driving wheel slack right and left, and 4R.

[0011] The electromotive driving gear 5 is equipped with the electric motors 7L and 7R of one pair of right and left attached in the gear case 6, and the differential gears 8L and 8R of one pair of power-transmission-device slack right and left within a gear case 6 as shown in drawing 2 .

[0012] Each electric motors 7L and 7R consist of DC brush motors which have Rota 7a, stator 7b, and brush 7c, and have connected the moderation gear trains 9L and 9R with 7d of output shafts of each electric motors 7L and 7R.

[0013] Each differential gears 8L and 8R consist of epicyclic gear type differential gears which have Sun Geer 8a, ring gear 8b, and carrier 8d that supports planetary pinion 8c which gears with these both gears 8a and 8b. While connecting Sun Geer 8a of each differential gears 8L and 8R with said each moderation gear trains 9L and 9R, carrier 8d of each differential gears 8L and 8R is connected with the axle of each rear wheels 4L and 4R through a constant-velocity joint 10. Moreover, ring gear 8b of the differential gears 8L and 8R on either side and 8b are connected, and it enables it to restrain rotation of ring gear 8b with the brake means 11.

[0014] The brake means 11 consists of dog clutches which consist of the movable dog 110 which made the periphery of ring gear 8b carry out spline engagement, and the fixed dog 111 which shaft orientations were made to counter to the movable dog 110, and was fixed in the gear case 6, the brake means 11 turns on by making dog gear-tooth 110a of the end (left end) of the movable dog 110 engage with dog gear-tooth 111a of the fixed dog 111, and rotation of ring gear 8b is restrained. And the solenoid 112 which turns the movable dog 110 to the fixed dog 111, and moves to shaft orientations is formed, and it is made to carry out on-off operation of the brake means 11 by the solenoid 112.

[0015] The solenoid 112 is equipped with rod 112c which resists spring 112b by the energization to the coil 112a, and is moved to shaft-orientations one side (left), attaches fork 112d which engages with rod 112c at the movable dog 110, and he is trying to make the movable dog 110 move to shaft orientations at rod 112c and one.

[0016] Electric motors 7L and 7R and a solenoid 112 The front-wheel rate sensors 12L and 12R of the right and left which detect the rotational speed VFL and VFR of each front wheels 3L and 3R on either side as shown in drawing 3 , Whenever [velocity-of-rear-wheel / of the right and left which detect the rotational speed VRL and VRR of each rear wheels 4L and 4R on either side] Sensors 13L and 13R, The brake switch 14, the accelerator switch 15, and the sensor 16 that detects the rotational frequency NE of an engine 1, The sensor 17 which detects the throttle opening theta of an engine 1, and the shift position sensor 18 of a change gear 2, The G sensor 19 before and after detecting the cross-direction acceleration which is acting on a car, It is controlled by the controller 21 which inputs the signal from the horizontal G sensor 20 which detects the longitudinal direction acceleration which is acting on a car, and a controller 21 performs start assistant control and revolution assistant control.

[0017] The detail is as being shown in drawing 4 , and the brake switch 14 turns it off (S1). ON (S2) and a change gear 2 An un-neutral condition (S3), [the accelerator switch 15] When four conditions of (S4) are satisfied the 1 (for example, 11 km/h) following, it is judged as the time of start. the 1st predetermined value VS from which VR (= (VRL+VRR)/2) serves as criteria of start decision whenever [average velocity-of-rear-wheel] -- When judged as the time of start, it distinguishes whether the start assistant flag F is set to "1" (S5), and if it is F= 0, difference **V with VR will distinguish whether it is more than predetermined reference-value **VS the average front-wheel rate VF (= (VFL+VFR)/2) and whenever [average velocity-of-rear-wheel] (S6). If it is **V>=**VS, while judging that front wheels 3L and 3R have slipped, and setting the start assistant flag F to "1" (S7), next energizing to a solenoid 112 and turning on the brake means 11 (S8), as for the normal rotation direction (at the time of advance), ** drives electric motors 7L and 7R in the inversion direction (at the time of go-astern). According to this, the output torque of each electric motors 7L and 7R is transmitted to each rear wheels 4L and 4R as driving force through each moderation gear trains 9L and 9R and each differential gears 8L and 8R, rear wheels 4L and 4R drive, and start is assisted.

[0018] There where to control the output torque of electric motors 7L and 7R on the occasion of start assistance so that rear wheels 4L and 4R do not slip is desired by the way, with this operation gestalt The angular acceleration dVRL and dVRR of each rear wheels 4L and 4R on either side is computed based on signal

change of Sensors 13L and 13R whenever [velocity-of-rear-wheel]. Distinguish (S91, S92), and if dVRL and dVRR are less than one dVRS(s) whether it is more than 1st set point dVRS1 (0.8G and G are gravitational acceleration by vehicle speed conversion) from which dVRL and dVRR serve as distinction criteria of a slip dVRL and dVRR distinguish whether it is below the 2nd set point dVRS2 (it is 0.4G by vehicle speed conversion) used as the distinction criteria of grip recovery (S101, S102). If dVRL and dVRR are two or less dVRS(s), the slip distinction flags FLS and FRS of each rear wheels 4L and 4R on either side will be reset to "0" (S111, S112), and desired value of the output torque of each electric motors 7L and 7R on either side will be made into the high set point TH (for example, 40kgfm(s)) (S121, S122). On the other hand, when dVRL and dVRR are set to one or more dVRS(s), FLS and FRS are set to "1" (S131, S132), and desired value of the output torque of each electric motors 7L and 7R is made into the set point TL of a low eye (for example, 10kgfm(s)) (S141, S142). Moreover, when it is dVRS2<dVRL and dVRR<dVRS1, it distinguishes whether FLS and FRS are set to "1" (S151, S152), if it is FLS and FRS=1, it will progress to the step of S141 and S142, and if it is FLS and FRS=0, it will progress to the step of S121 and S122. Thus, after setting up desired value, drive control of each electric motors 7L and 7R is carried out so that the output torque may become desired value (S161, S162).

[0019] In this way, until dVRL and dVRR are set to one or more dVRS(s) (i.e., until each rear wheels 4L and 4R slip) Once the output torque of each electric motors 7L and 7R is maintained by TH and each rear wheels 4L and 4R slip, the output torque of each electric motors 7L and 7R will fall to TL until dVRL and dVRR are set to two or less dVRS (i.e., until the grip of each rear wheels 4L and 4R is recovered). In addition, each electric motors 7L and 7R are controlled to change gradually towards [since the shock by rapid torque change although it changes to the shape of a step as a dotted line shows desired value to drawing 5 , if a motor current is changed to the shape of a step as it is occurs as an output torque shows drawing 5 as a continuous line] desired value.

[0020] When it became VR>=VS1 and is judged as the completion of start, or when it is judged with **V<**VS at the step of S6 even if it is at the start time While resetting the start assistant flag F to "0" (S17), stop the energization to a solenoid 112 and the brake means 11 is turned off (S18). Next, carry out another [of whether it became more than the 2nd predetermined value VS2 (for example, 20 km/h) which VR set up more highly than VS1] (S19), and if it is VR<VS2 While resetting the slip distinction flags FLS and FRS of each rear wheels 4L and 4R to "0", (S201, S202), and the drive of each electric motors 7L and 7R are stopped (S211, S212). If the brake means 11 is turned off and constraint of ring gear 8b is canceled, unless ring gear 8b races in carrier 8d of differential gears 8L and 8R, and this direction and produces the difference rotation between rear wheel 4L on either side and 4R, Sun Geer 8a of differential gears 8L and 8R will not rotate, and the reverse drive from the rear wheel 4L side of electric motors 7L and 7R and the 4R side will not be produced.

[0021] When it becomes VR>=VS2, the desired value MA of the revolution assistant moment set up as the driving force of front wheels 3L and 3R is computed from the cross-direction acceleration which is acting on a car, an engine speed NE, and the throttle opening theta and the change gear ratio of a change gear 2 and it is shown in drawing 6 by making into a parameter this front-wheel drive force and longitudinal direction acceleration which is acting on a car is computed by map retrieval (S22). In addition, this desired value MA becomes zero at the time of the rectilinear propagation to which longitudinal direction acceleration serves as zero, and it is set up so that it may increase with the increment in longitudinal direction acceleration and the front-wheel drive force.

[0022] When the revolution assistant moment is required, while rotating the electric motor by the side of an outer ring of spiral wound gasket normally among the electric motors 7L and 7R on either side, with the brake means 11 turned off, the electric motor by the side of an inner ring of spiral wound gasket is reversed. For example, at the time of clockwise rotation, while rotating left-hand side electric motor 7L normally, right-hand side electric motor 7R is reversed. While according to this Sun Geer 8a of left-hand side differential-gear 8L rotates normally and the carrier 7d rotates normally to ring gear 7b, Sun Geer 8a of right-hand side differential-gear 8R is reversed, and the carrier 8d is reversed to ring gear 8b. In this case, although the reaction force of the inversion direction acts on ring gear 8b of left-hand side differential-gear 8L and the reaction force of the normal rotation direction acts on ring gear 8b of right-hand side differential-gear 8R, since both the ring gears 8b and 8b are connected with **, both reaction force is negated. Therefore, it accelerates carrier 8d of left-hand side differential-gear 8L, i.e., left rear ring 4L, on the basis of the rotational speed of ring gear 8b, and carrier 8d of right-hand side differential-gear 8R, i.e., right rear ring 4R, is slowed down. In this way, damping force is given to outer-ring-of-spiral-wound-gasket slack left rear ring 4L at driving force and inner-ring-of-spiral-wound-gasket slack right rear ring 4R, the yaw moment to the clockwise rotation direction occurs, and revolution is assisted.

[0023] If revolution assistant control is succeedingly carried out to start assistant control, even if it will stop the energization to a solenoid 112 here Torque acts on the brake means 11 by the drive of the electric motors 7L

and 7R of right and left for revolution assistance. The gear-tooth side faces of the dog gear teeth 110a and 111a of the movable dog 110 and the fixed dog 111 carry out a pressure welding by this torque, it becomes impossible by friction between gear-tooth side faces breaking away the movable dog 110 from the fixed dog 111 by the energization force of spring 112b, and the brake means 11 will remain being ON. However, with this operation gestalt, it can prevent that revolution assistant control is not performed after becoming VR>=VS1 and completing start assistant control until VR goes up to VS2, but the brake means 11 is certainly turned off in the meantime, therefore revolution assistant control is performed while the brake means 11 has been ON.

[0024] In addition, if the output torque of electric motors 7L and 7R is started so that the revolution assistant moment of the desired value MA computed at the step of S22 may be obtained from the time of initiation of revolution assistant control, a result at which a car turns suddenly during revolution acceleration in the place which became VR>=VS2 will be brought, and a shock will be produced in car behavior. With this operation gestalt, then, as a correction factor of the revolution assistant moment The vehicle speed multiplier K increased gradually from 0 to 1 with the increment in VR between VS2 and the 3rd predetermined value VS 3 (for example, 30 km/h) set up more highly than this as shown in drawing 7 is set up. It distinguished whether VR was set to three or more VS (S23), and if it is VR<VS3, the vehicle speed multiplier K according to VR would be computed by table retrieval (S24), and the desired value MA of the revolution assistant moment will be amended to the value which carried out the multiplication of the vehicle speed multiplier K (S25).

[0025] And the desired value of the normal rotation torque of the electric motor by the side of an outer ring of spiral wound gasket required to obtain the revolution assistant moment of desired value MA and the desired value of the inversion torque of the electric motor by the side of an inner ring of spiral wound gasket are computed (S261, S262), and while carrying out the normal rotation drive of the electric motor by the side of an outer ring of spiral wound gasket so that the torque of this desired value may be outputted, the inversion drive of the electric motor by the side of an inner ring of spiral wound gasket is carried out (S271, S272). If revolution assistant control is started in this way in the place which became VR>=VS2 during revolution acceleration, by the time it is accelerated from VS2 to VS3, the revolution assistant moment will be gradually increased towards desired value MA, and revolution assistance will be performed smoothly, without producing the shock of car behavior.

[0026] As mentioned above, although the 1st operation gestalt which performs start assistance and revolution assistance using the electric motors 7L and 7R of one pair of right and left was explained, it is also possible to perform start assistance and revolution assistance using one electric motor 7 like the 2nd operation gestalt shown in drawing 8 . One pair of bevel-gear type differential gears 80L and 80R constitute the power transmission device between an electric motor 7 and the rear wheels 4L and 4R on either side from the 2nd operation gestalt.

[0027] Each differential gears 80L and 80R support to revolve pinion 80d which gears with one pair of side gears 80b and 80c and both the side gears 80b and 80c which change from bevel gear to differential-case 80a, change, and have connected 1st side gear 80b inside [shaft-orientations] both the differential gears 80L and 80R, and 80b. and both the differential gears 80L and 80R -- on the other hand, the electric motor 7 was connected with differential-case 80a of right-hand side differential-gear 80R through the gear train 9, and 2nd side gear 80c of the shaft-orientations outside of this differential-gear 80R is connected with the axle of right rear ring 4R through a constant-velocity joint 10. The baffle of the differential-case 80a of left-hand side differential-gear 80L is carried out, and he is trying to connect alternatively the constant-velocity joint 10 connected with the axle of left rear ring 4L at 1st side gear 80b inside [shaft-orientations] this differential-gear 80L, and outside 2nd side gear 80c through a means for switching 22. Movable dog 22a which made the constant-velocity joint 10 for left rear ring 4L enable baffle engagement of the sliding of shaft orientations of a means for switching 22, It consists of dog clutches which have the fixed dogs 22b and 22c attached in 1st side gear 80b of left-hand side differential-gear 80L, and 2nd side gear 80c, respectively. He makes movable dog 22a move by solenoid 22d controlled by the controller outside drawing, and is trying to make it engage with both the fixed dogs 22b and 22c alternatively.

[0028] If the constant-velocity joint 10 for left rear ring 4L is connected with 1st side gear 80b of left-hand side differential-gear 80L If it will be directly linked with 1st side gear 80b of right-hand side differential-gear 80R by left rear ring 4L and it rotates normally or reverses differential-case 80a of right-hand side differential-gear 80R with an electric motor 7 Both the rear wheels 4L and 4R on either side are rotated normally or reversed, and start assistance of advance or go-astern is performed.

[0029] If the constant-velocity joint 10 for left rear ring 4L is connected with 2nd side gear 80c of left-hand side differential-gear 80L, as long as 1st side gear 80b will rotate to an opposite direction at left rear ring 4L and uniform velocity and the rear wheels 4L and 4R on either side will rotate at uniform velocity, differential-case 80a of right-hand side differential-gear 80R does not rotate. And if differential-case 80a of right-hand side

differential-gear 80R is rotated normally with an electric motor 7 If accelerating rotation of the 2nd side gear 80c of this differential-gear 80R is carried out to 1st side gear 80b, and it accelerates right rear ring 4R rather than left rear ring 4L and differential-case 80a of right-hand side differential-gear 80R is reversed Accelerating rotation of the 1st side gear 80b is carried out to 2nd side gear 80c of this differential-gear 80R, it accelerates left rear ring 4L rather than right rear ring 4R, and revolution assistance is performed.

[0030] Also in the 2nd operation gestalt, like the above from and the thing for which the output torque of an electric motor 7 is controlled according to the angular acceleration of rear wheels 4L and 4R By forbidding activation of revolution assistant control until it controls a slip of a rear wheel, and it can improve the certainty of start assistance and it becomes VR>=VS2 It can prevent that revolution assistant control is performed while the means for switching 22 had been held at the condition of linking the constant-velocity joint 10 for left rear ring 4L with 1st side gear 80b of left-hand side differential-gear 80L directly. Furthermore, revolution assistance can be smoothly performed by amending the desired value MA of the revolution assistant moment using the vehicle speed multiplier K, without producing the shock of car behavior.

[0031] Moreover, activation of revolution assistant control forbids until it carries out predetermined-time progress from the completion point in time of start assistant control, and the revolution assistant moment may be made it being increased gradually from the initiation time of revolution assistant control with the above-mentioned operation gestalt, although the gradual increase of the prohibition period of the revolution assistant control after completion of start assistant control and the revolution assistant moment after initiation of revolution assistant control has specified based on VR (the vehicle speed) with time towards desired value MA.

[0032]

[Effect of the Invention] According to this invention, according to the road surface mu of the touch-down part of a coupled driving wheel, the output torque of an electric motor is controlled appropriately, and the certainty of start assistance can be improved so that clearly from the above explanation.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the example of use of this invention equipment
[Drawing 2] The sectional view of the 1st operation gestalt of this invention equipment
[Drawing 3] The block diagram of the control system of the 1st operation gestalt
[Drawing 4] The flow Fig. showing the control program of the 1st operation gestalt
[Drawing 5] The graph which shows torque change of the electric motor at the time of start assistance
[Drawing 6] The graph which shows a setup of the desired value of the revolution assistant moment
[Drawing 7] The graph which shows a setup of a vehicle speed multiplier
[Drawing 8] The skeleton Fig. showing the 2nd operation gestalt of this invention equipment
[Description of Notations]
1 Engine 3L, 3R Front Wheel (Driving Wheel)
4L, 4R Rear wheel (coupled driving wheel) 5 Electromotive driving gear
7L, 7R Electric motor 21 Controller

[Translation done.]

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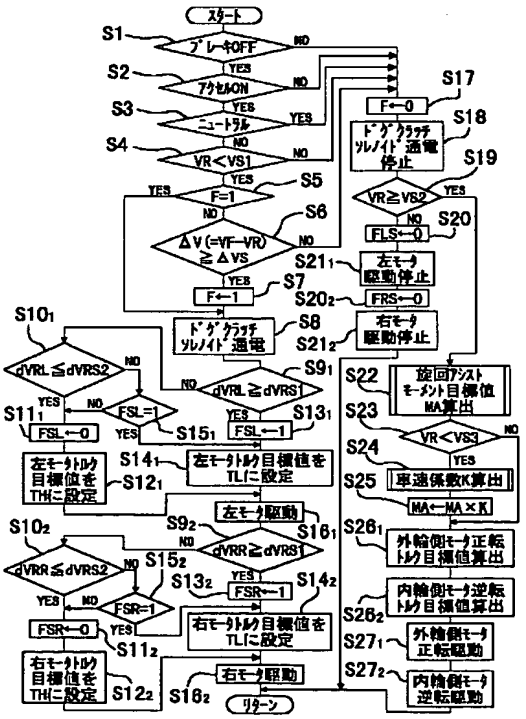
(54)【発明の名称】　車両用電動式駆動装置

(57)【要約】
【課題】　エンジンで駆動されない従動輪を電動モータで駆動して車両の発進をアシストするものにおいて、従動輪の接地部分の路面μに応じて電動モータの出力トルクを適切に制御して、発進アシストの確実性を向上させる。
【解決手段】　従動輪の接地部分の路面μが低く、従動輪がスリップ気味になってその角加速度ｄＶＲＬ，ｄＶＲＲがスリップの判別基準となる設定値ｄＶＲＳ１以上になったときは、電動モータの出力トルクを低い値ＴＬにし、ｄＶＲＬ，ｄＶＲＲがグリップ回復の判別基準となる設定値ｄＶＲＳ２以下になったとき、電動モータの出力トルクを高い値ＴＨにする。



【特許請求の範囲】

【請求項１】　前輪と後輪との一方をエンジンで駆動される駆動輪、他方を従動輪とする車両に、電動モータにより従動輪を駆動して車両の発進をアシストすべく設ける車両用電動式駆動装置において、

電動モータによる従動輪の駆動時に、従動輪の角加速度に応じて電動モータの出力トルクを増減制御する制御手段を備える、

ことを特徴とする車両用電動式駆動装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、前輪と後輪との一方をエンジンで駆動される駆動輪、他方を従動輪とする車両に搭載する車両用電動式駆動装置に関する。

【０００２】

【従来の技術】従来、この種の装置として、雪道等の低μ路（μは摩擦係数）での発進時に、電動モータにより従動輪を駆動して車両の発進をアシストするようにしたものが知られているが、路面のμに対し従動輪の駆動力が過大であると、従動輪がスリップして発進アシストの効果が得られなくなることがある。

【０００３】そこで、駆動輪と従動輪との回転速度差から駆動輪のスリップ率を演算し、このスリップ率と駆動輪の駆動力との相関関係から路面のμを求め、電動モータの出力トルクをこのμに応じた値に制御することにより発進アシスト時の従動輪のスリップを防止するようにしたものも知られている（特開平８－３００９６５号公報参照）。

【０００４】

【発明が解決しようとする課題】上記従来例のもので求めているのは駆動輪の接地部分の路面μであり、従動輪の接地部分の路面μが駆動輪の接地部分の路面μより低い場合は、電動モータの出力トルクが過大となって従動輪のスリップを生じ、逆に駆動輪の接地部分の路面μより高い部分は、電動モータの出力トルクが不必要に規制され、発進アシストの確実性が損われる不具合がある。

【０００５】本発明は、以上の点に鑑み、従動輪の接地部分の路面μに応じて電動モータの出力トルクを適切に制御することにより発進アシストの確実性を向上し得るようにした車両用電動式駆動装置を提供することを課題としている。

【０００６】

【課題を解決するための手段】上記課題を解決すべく、本発明は、前輪と後輪との一方をエンジンで駆動される駆動輪、他方を従動輪とする車両に、電動モータにより従動輪を駆動して車両の発進をアシストすべく設ける車両用電動式駆動装置において、電動モータによる従動輪の駆動時に、従動輪の角加速度に応じて電動モータの出力トルクを増減制御する制御手段を備えている。

【０００７】従動輪の接地部分の路面μに対し従動輪の駆動力が過大になって従動輪がスリップすると、従動輪の角加速度が増加する。従って、従動輪の角加速度は従動輪の接地部分の路面μを表わすパラメータとなり、この角加速度に応じて電動モータの出力トルクを増減することにより、電動モータの出力トルクは従動輪の接地部分の路面μに応じて適切に制御されることになる。

【０００８】具体的には、従動輪の接地部分の路面μが低く、従動輪がスリップ気味になって角加速度が増加したときは、電動モータの出力トルクを減少させて早期にグリップを回復し、路面μが高く角加速度が増加しないときは、電動モータの出力トルクを増加させて、発進アシストを効率良く行うことができる。

【０００９】尚、後記する実施形態において、上記制御手段に相当するのは図４のＳ９$_1$，Ｓ９$_2$のステップからＳ１４$_1$，Ｓ１４$_2$のステップまでの処理である。

【００１０】

【発明の実施の形態】図１は、エンジン１により変速機２を介して左右の前輪３Ｌ，３Ｒを駆動する前輪駆動車両を示しており、従動輪たる左右の後輪４Ｌ，４Ｒ間に電動式駆動装置５を設けている。

【００１１】電動式駆動装置５は、図２に示す如く、ギアケース６に取付けた左右１対の電動モータ７Ｌ，７Ｒと、ギアケース６内の動力伝達機構たる左右１対の差動装置８Ｌ，８Ｒとを備えている。

【００１２】各電動モータ７Ｌ，７Ｒは、ロータ７ａとステータ７ｂとブラシ７ｃとを有するＤＣブラシモータで構成されており、各電動モータ７Ｌ，７Ｒの出力軸７ｄに減速ギア列９Ｌ，９Ｒを連結している。

【００１３】各差動装置８Ｌ，８Ｒは、サンギア８ａと、リングギア８ｂと、該両ギア８ａ，８ｂに噛合するプラネタリピニオン８ｃを担持するキャリア８ｄとを有する遊星歯車式差動装置で構成されており、各差動装置８Ｌ，８Ｒのサンギア８ａを前記各減速ギア列９Ｌ，９Ｒに連結すると共に、各差動装置８Ｌ，８Ｒのキャリア８ｄを各後輪４Ｌ，４Ｒの車軸に等速ジョイント１０を介して連結している。また、左右の差動装置８Ｌ，８Ｒのリングギア８ｂ，８ｂ同士を連結し、リングギア８ｂの回転をブレーキ手段１１で拘束し得るようにしている。

【００１４】ブレーキ手段１１は、リングギア８ｂの外周にスプライン係合させた可動ドグ１１０と、可動ドグ１１０に対し軸方向に対向させてギアケース６内に固定した固定ドグ１１１とから成るドグクラッチで構成されており、可動ドグ１１０の一端（左端）のドグ歯１１０ａを固定ドグ１１１のドグ歯１１１ａに係合させることでブレーキ手段１１がオンしてリングギア８ｂの回転が拘束される。そして、可動ドグ１１０を固定ドグ１１１に向けて軸方向に進退するソレノイド１１２を設け、ソレノイド１１２によってブレーキ手段１１をオンオフ操作するようにしている。

【００１５】ソレノイド１１２は、そのコイル１１２ａへの通電でばね１１２ｂに抗して軸方向一方（左方）に移動されるロッド１１２ｃを備えており、ロッド１１２ｃに可動ドグ１１０に係合するフォーク１１２ｄを取付けて、可動ドグ１１０をロッド１１２ｃと一体に軸方向に進退させるようにしている。

【００１６】電動モータ７Ｌ，７Ｒとソレノイド１１２とは、図３に示す如く、左右の各前輪３Ｌ，３Ｒの回転速度ＶＦＬ，ＶＦＲを検出する左右の前輪速度センサ１２Ｌ，１２Ｒと、左右の各後輪４Ｌ，４Ｒの回転速度ＶＲＬ，ＶＲＲを検出する左右の後輪速度センサ１３Ｌ，１３Ｒと、ブレーキスイッチ１４と、アクセルスイッチ１５と、エンジン１の回転数ＮＥを検出するセンサ１６と、エンジン１のスロットル開度θを検出するセンサ１７と、変速機２のシフトポジションセンサ１８と、車両に作用している前後方向加速度を検出する前後Ｇセンサ１９と、車両に作用している横方向加速度を検出する横Ｇセンサ２０とからの信号を入力するコントローラ２１により制御されるようになっており、コントローラ２１で発進アシスト制御と旋回アシスト制御とを行う。

【００１７】その詳細は図４に示す通りであり、ブレーキスイッチ１４がオフ（Ｓ１）、アクセルスイッチ１５がオン（Ｓ２）、変速機２が非ニュートラル状態（Ｓ３）、平均後輪速度ＶＲ（＝（ＶＲＬ＋ＶＲＲ）／２）が発進判断の基準となる第１の所定値ＶＳ１（例えば１１Ｋｍ／ｈ）未満（Ｓ４）という４条件が成立したときに発進時と判断し、発進時と判断されたときは、発進アシストフラグＦが「１」にセットされているか否かを判別し（Ｓ５）、Ｆ＝０であれば、平均前輪速度ＶＦ（＝（ＶＦＬ＋ＶＦＲ）／２）と平均後輪速度ＶＲとの差△Ｖが所定の基準値△ＶＳ以上か否かを判別する（Ｓ６）。△Ｖ≧△ＶＳであれば前輪３Ｌ，３Ｒがスリップしていると判断して、発進アシストフラグＦを「１」にセットし（Ｓ７）、次に、ソレノイド１１２に通電してブレーキ手段１１をオンすると共に（Ｓ８）、電動モータ７Ｌ，７Ｒを正転方向（前進時）はたは逆転方向（後進時）に駆動する。これによれば、各電動モータ７Ｌ，７Ｒの出力トルクが各減速ギア列９Ｌ，９Ｒと各差動装置８Ｌ，８Ｒとを介して各後輪４Ｌ，４Ｒに駆動力として伝達され、後輪４Ｌ，４Ｒが駆動されて発進がアシストされる。

【００１８】ところで、発進アシストに際しては、後輪４Ｌ，４Ｒがスリップしないように電動モータ７Ｌ，７Ｒの出力トルクを制御することが望まれる、そこで、本実施形態では、左右の各後輪４Ｌ，４Ｒの角加速度ｄＶＲＬ，ｄＶＲＲを後輪速度センサ１３Ｌ，１３Ｒの信号変化に基づいて算出し、ｄＶＲＬ，ｄＶＲＲがスリップの判別基準となる第１設定値ｄＶＲＳ１（車速換算で例えば０．８Ｇ，Ｇは重力加速度）以上であるか否かを判別し（$S9_1$，$S9_2$）、ｄＶＲＬ，ｄＶＲＲがｄＶＲＳ１未満であれば、ｄＶＲＬ，ｄＶＲＲがグリップ回復の判別基準となる第２設定値ｄＶＲＳ２（車速換算で例えば０．４Ｇ）以下であるか否かを判別する（$S10_1$，$S10_2$）。ｄＶＲＬ，ｄＶＲＲがｄＶＲＳ２以下であれば、左右の各後輪４Ｌ，４Ｒのスリップ判別フラグＦＬＳ，ＦＲＳを「０」にリセットし（$S11_1$，$S11_2$）、左右の各電動モータ７Ｌ，７Ｒの出力トルクの目標値を高目の設定値ＴＨ（例えば４０ｋｇｆｍ）にする（$S12_1$，$S12_2$）。一方、ｄＶＲＬ，ｄＶＲＲがｄＶＲＳ１以上になったときは、ＦＬＳ，ＦＲＳを「１」にセットし（$S13_1$，$S13_2$）、各電動モータ７Ｌ，７Ｒの出力トルクの目標値を低目の設定値ＴＬ（例えば１０ｋｇｆｍ）にする（$S14_1$，$S14_2$）。また、ｄＶＲＳ２＜ｄＶＲＬ，ｄＶＲＲ＜ｄＶＲＳ１であるときは、ＦＬＳ，ＦＲＳが「１」にセットされているか否かを判別し（$S15_1$，$S15_2$）、ＦＬＳ，ＦＲＳ＝１であれば$S14_1$，$S14_2$のステップに進み、ＦＬＳ，ＦＲＳ＝０であれば、$S12_1$，$S12_2$のステップに進む。このようにして、目標値を設定した後、各電動モータ７Ｌ，７Ｒをその出力トルクが目標値になるように駆動制御する（$S16_1$，$S16_2$）。

【００１９】かくて、ｄＶＲＬ，ｄＶＲＲがｄＶＲＳ１以上になるまで、即ち、各後輪４Ｌ，４Ｒがスリップするまで、各電動モータ７Ｌ，７Ｒの出力トルクはＴＨに維持され、各後輪４Ｌ，４Ｒが一旦スリップすると、ｄＶＲＬ，ｄＶＲＲがｄＶＲＳ２以下になるまで、即ち、各後輪４Ｌ，４Ｒのグリップが回復するまで、各電動モータ７Ｌ，７Ｒの出力トルクはＴＬに低下される。尚、目標値は図５に点線で示す如くステップ状に変化するが、そのままモータ電流をステップ状に変化させると、急激なトルク変化によるショックが発生するため、出力トルクが図５に実線で示す如く目標値に向けて徐々に変化するように各電動モータ７Ｌ，７Ｒを制御する。

【００２０】ＶＲ≧ＶＳ１となって発進完了と判断したときや、発進時であってもＳ６のステップで△Ｖ＜△ＶＳと判定されたときは、発進アシストフラグＦを「０」にリセットすると共に（Ｓ１７）、ソレノイド１１２への通電を停止してブレーキ手段１１をオフし（Ｓ１８）、次に、ＶＲがＶＳ１より高く設定した第２の所定値ＶＳ２（例えば２０ｋｍ／ｈ）以上になったか否かを別し（Ｓ１９）、ＶＲ＜ＶＳ２であれば、各後輪４Ｌ，４Ｒのスリップ判別フラグＦＬＳ，ＦＲＳを「０」にリセットすると共に、（$S20_1$，$S20_2$）、各電動モータ７Ｌ，７Ｒの駆動を停止する（$S21_1$，$S21_2$）。ブレーキ手段１１をオフしてリングギア８ｂの拘束を解除すると、リングギア８ｂが差動装置８Ｌ，８Ｒのキャリア８ｄと同方向に空転し、左右の後輪４Ｌ，４Ｒ間の差回転を生じない限り差動装置８Ｌ，８Ｒのサンギア８ａは回転せず、電動モータ７Ｌ，７Ｒの後輪４Ｌ，４Ｒ側からの逆駆動は生じない。

【００２１】ＶＲ≧ＶＳ２になったときは、車両に作用している前後方向加速度と、エンジン回転数ＮＥと、スロットル開度θと、変速機２の変速比とから前輪３Ｌ，３Ｒの駆動力を算出し、この前輪駆動力と車両に作用している横方向加速度とをパラメータとして図６に示す如く設定されている旋回アシストモーメントの目標値ＭＡをマップ検索で算出する（Ｓ２２）。尚、この目標値ＭＡは、横方向加速度が零となる直進時に零になり、横方向加速度及び前輪駆動力の増加に伴い増加するように設定されている。

【００２２】旋回アシストモーメントが要求されたときは、ブレーキ手段１１をオフしたまま左右の電動モータ７Ｌ，７Ｒのうち外輪側の電動モータを正転させると共に内輪側の電動モータを逆転させる。例えば、右旋回時には、左側の電動モータ７Ｌを正転させると共に右側の電動モータ７Ｒを逆転させる。これによれば、左側の差動装置８Ｌのサンギア８ａが正転されてそのキャリア７ｄがリングギア７ｂに対し正転されると共に、右側の差動装置８Ｒのサンギア８ａが逆転されてそのキャリア８ｄがリングギア８ｂに対し逆転される。この場合、左側の差動装置８Ｌのリングギア８ｂには逆転方向の反力が作用し、右側の差動装置８Ｒのリングギア８ｂには正転方向の反力が作用するが、両リングギア８ｂ，８ｂは互に連結されているため、両反力は打消される。従って、リングギア８ｂの回転速度を基準にして、左側の差動装置８Ｌのキャリア８ｄ、即ち、左後輪４Ｌが増速され、右側の差動装置８Ｒのキャリア８ｄ、即ち、右後輪４Ｒが減速される。かくて、外輪たる左後輪４Ｌに駆動力、内輪たる右後輪４Ｒに制動力が付与されて右旋回方向へのヨーモメントが発生し、旋回がアシストされる。

【００２３】ここで、発進アシスト制御に引続いて旋回アシスト制御が行われると、ソレノイド１１２への通電を停止しても、旋回アシストのための左右の電動モータ７Ｌ，７Ｒの駆動でブレーキ手段１１にトルクが作用し、このトルクにより可動ドグ１１０及び固定ドグ１１１のドグ歯１１０ａ，１１１ａの歯側面同士が圧接し、歯側面間の摩擦により可動ドグ１１０がばね１１２ｂの付勢力では固定ドグ１１１から離脱不能となり、ブレーキ手段１１がオンのままになってしまう。然し、本実施形態では、ＶＲ≧ＶＳ１になって発進アシスト制御が完了してからＶＲがＶＳ２に上昇するまで旋回アシスト制御は実行されず、その間にブレーキ手段１１は確実にオフされ、従って、ブレーキ手段１１がオンのまま旋回アシスト制御が実行されることを防止できる。

【００２４】尚、旋回アシスト制御の開始当初から、Ｓ２２のステップで算出した目標値ＭＡの旋回アシストモーメントが得られるように電動モータ７Ｌ，７Ｒの出力トルクを立上げると、旋回加速中にＶＲ≧ＶＳ２になったところで車両が急に曲がる結果となり、車両挙動にショックを生ずる。そこで、本実施形態では、旋回アシストモーメントの補正係数として、図７に示す如くＶＳ２とこれより高く設定した第３の所定値ＶＳ３（例えば３０ｋｍ／ｈ）との間でＶＲの増加に伴い０から１に漸増する車速係数Ｋを設定し、ＶＲがＶＳ３以上になったか否かを判別して（Ｓ２３）、ＶＲ＜ＶＳ３であれば、ＶＲに応じた車速係数Ｋをテーブル検索で算出し（Ｓ２４）、旋回アシストモーメントの目標値ＭＡを車速係数Ｋを乗算した値に補正している（Ｓ２５）。

【００２５】そして、目標値ＭＡの旋回アシストモーメントを得るのに必要な外輪側の電動モータの正転トルクの目標値と内輪側の電動モータの逆転トルクの目標値とを算出し（$S26_1$，$S26_2$）、この目標値のトルクが出力されるように外輪側の電動モータを正転駆動すると共に内輪側の電動モータを逆転駆動している（$S27_1$，$S27_2$）。かくて、旋回加速中にＶＲ≧ＶＳ２になったところで旋回アシスト制御が開始されると、ＶＳ２からＶＳ３に加速されるまでの間に旋回アシストモーメントが徐々に目標値ＭＡに向けて増加され、車両挙動のショックを生ずることなくスムーズに旋回アシストが行われる。

【００２６】以上、左右１対の電動モータ７Ｌ，７Ｒを用いて発進アシストと旋回アシストとを行う第１実施形態について説明したが、図８に示す第２実施形態の如く、１個の電動モータ７を用いて発進アシストと旋回アシストとを行うことも可能である。第２実施形態では、電動モータ７と左右の後輪４Ｌ，４Ｒとの間の動力伝達機構を１対の傘歯車式差動装置８０Ｌ，８０Ｒで構成している。

【００２７】各差動装置８０Ｌ，８０Ｒは、デフケース８０ａに傘歯車から成る１対のサイドギア８０ｂ，８０ｃと両サイドギア８０ｂ，８０ｃに噛合するピニオン８０ｄとを軸支して成るもので、両差動装置８０Ｌ，８０Ｒの軸方向内側の第１サイドギア８０ｂ，８０ｂ同士を連結している。そして、両差動装置８０Ｌ，８０Ｒの一方、例えば、右側の差動装置８０Ｒのデフケース８０ａに電動モータ７をギア列９を介して連結し、該差動装置８０Ｒの軸方向外側の第２サイドギア８０ｃを等速ジョイント１０を介して右後輪４Ｒの車軸に連結している。左側の差動装置８０Ｌのデフケース８０ａは回り止めされており、該差動装置８０Ｌの軸方向内側の第１サイドギア８０ｂと外側の第２サイドギア８０ｃとに左後輪４Ｌの車軸に連結される等速ジョイント１０を切換手段２２を介して選択的に連結するようにしている。切換手段２２は、左後輪４Ｌ用の等速ジョイント１０に軸方向に摺動自在に回り止め係合させた可動ドグ２２ａと、左側の差動装置８０Ｌの第１サイドギア８０ｂと第２サイドギア８０ｃとに夫々取付けた固定ドグ２２ｂ，２２ｃとを有するドグクラッチで構成されており、図外のコントローラで制御されるソレノイド２２ｄにより可動ドグ２２ａを進退させて、両固定ドグ２２ｂ，２２ｃに選択的

に係合させるようにしている。

【００２８】左後輪４Ｌ用の等速ジョイント１０を左側の差動装置８０Ｌの第１サイドギア８０ｂに連結すると、左後輪４Ｌが右側の差動装置８０Ｒの第１サイドギア８０ｂに直結された状態になり、電動モータ７により右側の差動装置８０Ｒのデフケース８０ａを正転または逆転すると、左右の後輪４Ｌ，４Ｒが共に正転または逆転されて、前進または後進の発進アシストが行われる。

【００２９】左後輪４Ｌ用の等速ジョイント１０を左側の差動装置８０Ｌの第２サイドギア８０ｃに連結すると、第１サイドギア８０ｂが左後輪４Ｌと等速度で反対方向に回転し、左右の後輪４Ｌ，４Ｒが等速度で回転している限り、右側の差動装置８０Ｒのデフケース８０ａは回転しない。そして、電動モータ７により右側の差動装置８０Ｒのデフケース８０ａを正転すると、該差動装置８０Ｒの第２サイドギア８０ｃが第１サイドギア８０ｂに対し増速回転されて、右後輪４Ｒが左後輪４Ｌよりも増速され、また、右側の差動装置８０Ｒのデフケース８０ａを逆転すると、該差動装置８０Ｒの第２サイドギア８０ｃに対し第１サイドギア８０ｂが増速回転されて、左後輪４Ｌが右後輪４Ｒよりも増速され、旋回アシストが行われる。

【００３０】そして、第２実施形態においても、上記と同様に、後輪４Ｌ，４Ｒの角加速度に応じて電動モータ７の出力トルクを制御することより、後輪のスリップを抑制して発進アシストの確実性を向上でき、また、ＶＲ≧ＶＳ２になるまで旋回アシスト制御の実行を禁止することにより、切換手段２２が左後輪４Ｌ用の等速ジョイント１０を左側の差動装置８０Ｌの第１サイドギア８０ｂに直結する状態に保持されたまま旋回アシスト制御が実行されることを防止でき、更に、旋回アシストモーメントの目標値ＭＡを車速係数Ｋを用いて補正することにより、車両挙動のショックを生ずることなくスムーズに旋回アシストを行うことができる。

【００３１】また、上記実施形態では、発進アシスト制御の完了後の旋回アシスト制御の禁止期間や、旋回アシスト制御の開始後の旋回アシストモーメントの漸増をＶＲ（車速）に基づいて規定しているが、発進アシスト制御の完了時点から所定時間経過するまで旋回アシスト制御の実行を禁止し、また、旋回アシストモーメントが旋回アシスト制御の開始時点から目標値ＭＡに向けて経時的に漸増されるようにしても良い。

【００３２】

【発明の効果】以上の説明から明らかなように、本発明によれば、従動輪の接地部分の路面μに応じて電動モータの出力トルクを適切に制御して、発進アシストの確実性を向上できる。

【図面の簡単な説明】

【図１】　本発明装置の使用例を示す図

【図２】　本発明装置の第１実施形態の断面図

【図３】　第１実施形態の制御系のブロック図

【図４】　第１実施形態の制御プログラムを示すフロー図

【図５】　発進アシスト時の電動モータのトルク変化を示すグラフ

【図６】　旋回アシストモーメントの目標値の設定を示すグラフ

【図７】　車速係数の設定を示すグラフ

【図８】　本発明装置の第２実施形態を示すスケルトン図

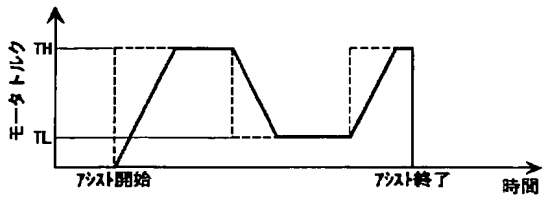
【符号の説明】

１　エンジン　　３Ｌ，３Ｒ　前輪（駆動輪）

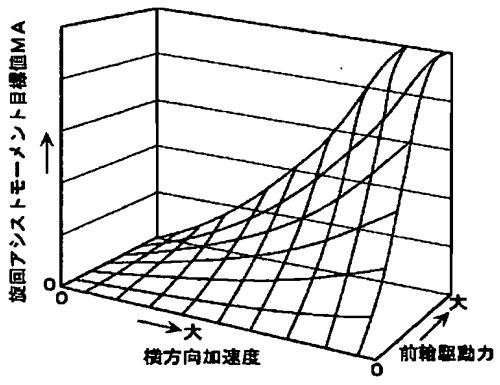
４Ｌ，４Ｒ　後輪（従動輪）　　５　電動式駆動装置

７Ｌ，７Ｒ　電動モータ　　２１　コントローラ

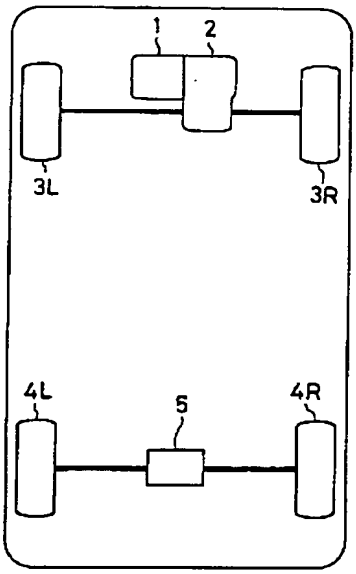
【図５】



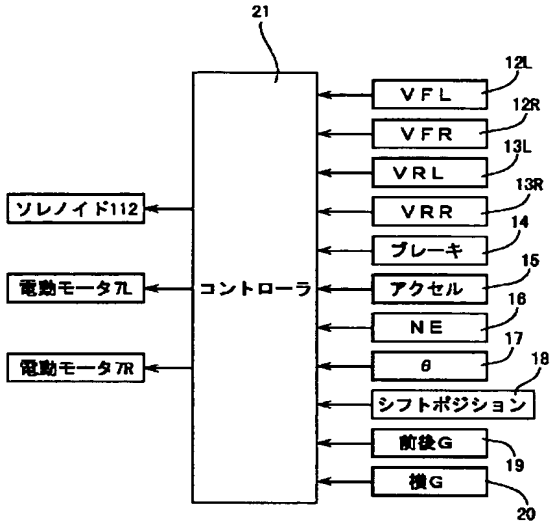
【図６】



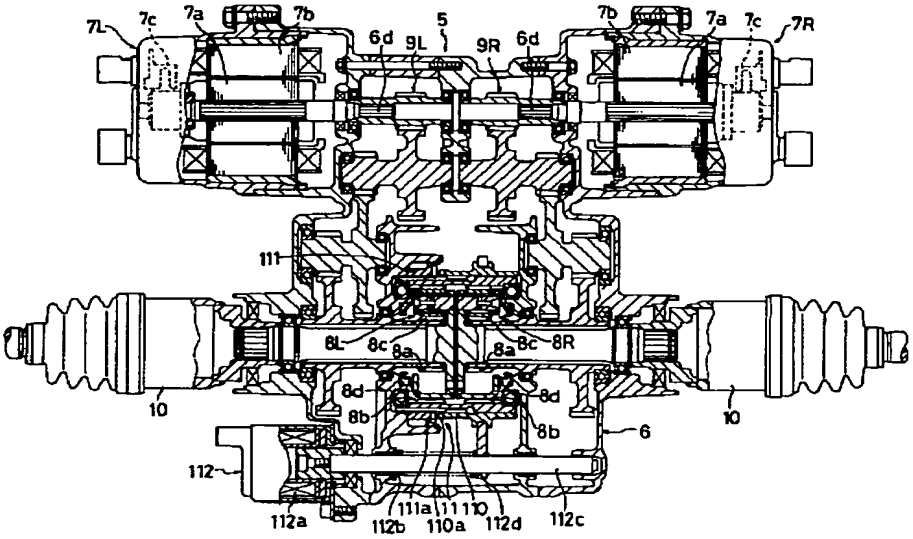
【図１】


1
2
3L
3R
4L
5
4R

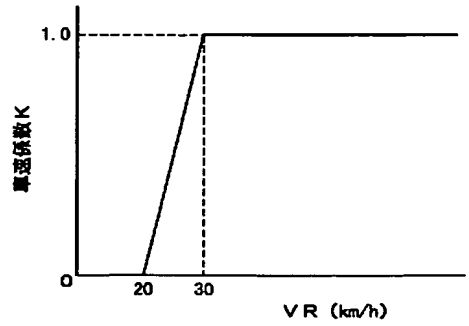
【図３】


21
コントローラ
ソレノイド112
電動モータ7L
電動モータ7R
VFL
VFR
VRL
VRR
ブレーキ
アクセル
NE
θ
シフトポジション
前後G
横G
12L
12R
13L
13R
14
15
16
17
18
19
20

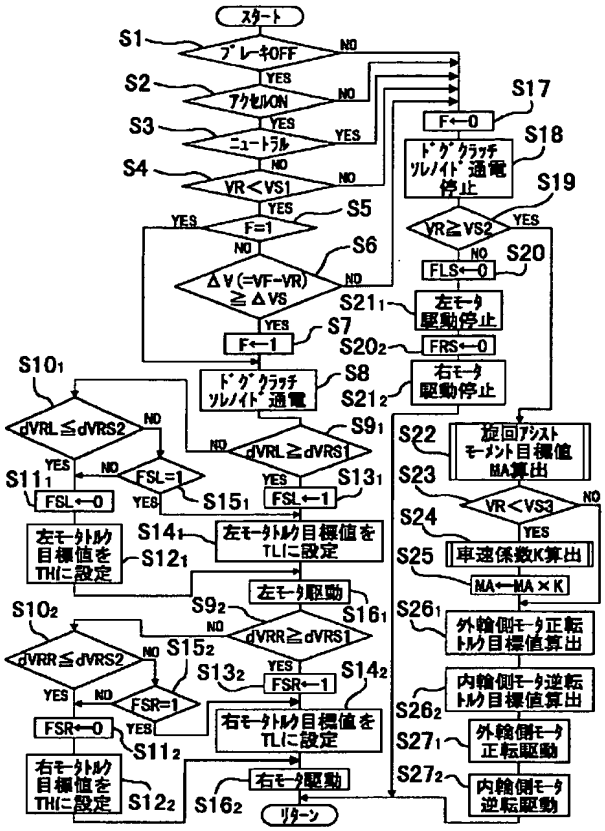
【図２】


7L
7c
7a
7b
6d
9L
5
9R
6d
7b
7a
7c
7R
111
8L
8c
8a
8a
8c
8R
8d
8b
8d
8b
10
10
6
112
112a
112b
111a
111
110a
110
112d
112c

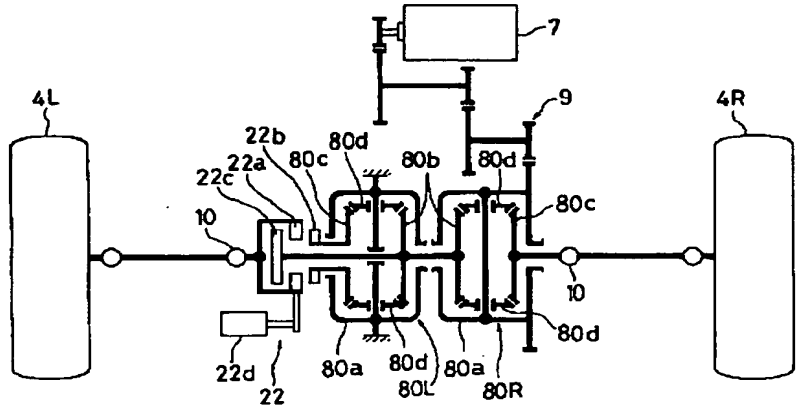
【図７】


1.0
0
20
30
VR (km/h)
車速係数K

【図４】



【図８】



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